PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN: OPTIMIZATION AND DEVELOPMENT OF ITS PRODUCTS

SHORT SYNOPSIS

Submitted in partial fulfillment of the requirement of the degree of

DOCTOR OF PHILOSOPHY

to

Manav Rachna International Institute of Research and Studies

(Deemed to be University)

Aneesha

Registration Number: 19/PhD/001

Under the supervision of

Supervisor

Dr. Pratibha Singh
Professor
Department of Nutrition and Dietetics
Faculty of Allied Health Sciences

Department of Nutrition and Dietetics

School of Allied Health Sciences

Manav Rachna International Institute of Research & Studies

Sector-43, Surajkund–Delhi Road, Faridabad– 121004

SCHOOL OF ALLIED HEALTH SCIENCES

Certificate

I hereby declare that the short synopsis titled "Physico-chemical characterization of Buckwheat grain: Optimization and development of its products " being submitted in fulfillment of the requirement for the degree of Doctor of Philosophy in the Department of Nutrition and Dietetics under the School of Allied Health Sciences of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2024-2025. It is a bona fide record of original work carried out under the supervision of Dr Pratibha Singh, Professor, Department of Nutrition and Dietetics. It has not been submitted in full or part to any other university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and proof has been submitted.

Aneesha
Registration Number: 19/PhD/001

Signature of the Supervisor
Dr. Pratibha Singh,
Professor,
Dept. of Nutrition and Dietetics
School of Allied Health Sciences
MRIIRS

(Chairperson, DRC)

(Dean, School of Allied Health Sciences)

ABSTRACT

Buckwheat is an ancient crop grown in hilly regions around the world. It is a highly sustainable crop due to its adaptability to various climatic conditions. It has grown for many years, but its production and importance have declined due to neglect and under-utilization in the world and India. This has shortened the supply chain while increasing the consumption limits. The present study aims to study the physicochemical properties of Buckwheat and the acceptability of its products. There is a need to analyze the nutritional profile of this under-utilized crop. This study focuses on the various physicochemical, and functional properties of Buckwheat that could meet the requirements of product-specific applications in the food industry. It will emerge as a superfood with strong potential in the food sector to combat nutritional problems and the global hunger crisis.

Keywords: *Buckwheat, chemical, food product, proximate, physical, nutritional profile, under-utilized, sustainable*

Table of Contents

Certificate i

Abstract ii

Table of Contents iii

S.No	Description	Page No
1	Description of Broad Area	1-2
2	Review of Literature 2.1 Buckwheat 2.2 Growth Conditions 2.3 Cultivation of Buckwheat 2.4 Nutritional Value 2.5 Flavonoids 2.6 Health Benefits 2.7 Culinary Uses	2-4
3	Research Gaps	4-5
4	Problem Statement	5
5	Research Objectives	5
6	Research Methodology	6-10
7	Expected Outcome of the Research	10
8	References Similarity Verification Report Grammarly Certificate	11-13

PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN: OPTIMIZATION AND DEVELOPMENT OF ITS PRODUCTS

1. DESCRIPTION OF THE BROAD AREA

India has a diverse variety of crop cultivation and nearly 1000 wild species of plants that are edible are found by native tribals(Das & Das, 2016). Buckwheat is a type of pseudocereal that has been cultivated since ancient times in the world and is underutilized (Farooq et al., 2016). Pseudocereals do not belong to grass species of plants (Das & Das, 2016). A few plants that can be utilized in India have been identified by the All India Coordinated Research Project (AICRP) especially the pseudocereals (Amaranth, Quinoa, and Buckwheat)(Das & Das, 2016).

Buckwheat has been cultivated for many years but its production has been declining and its importance has reduced over time owing to it being neglected and under-utilized crop. This has reduced the supply chain and increased the usage constraints.

Buckwheat has diverse nutrients and bioactive compounds with many health benefits. Buckwheat has strong potential in the field of human nutrition is neglected and its awareness has not been brought to humans. Unlike Quinoa, many under-utilized grains like Buckwheat have not received much media and market attention (Bekkering & Tian, 2019). Any investment in production to consumption is unfavorable to improve utilization without any awareness of technological considerations for its use. The market attention brought about Quinoa by many influential personalities has contributed to its global spike in cultivation and utilization (Bazile et al., 2016)

With the growing population and various climatic changes, there is an increased food demand, and food security has become a crucial challenge for most developing countries. Among the plant sources Humans depend majorly on cereals for consumption. Cereals have been in demand for many centuries. Approximately 80% of the food consumption in India comes from wheat, rice, and maize (Pirzadah & Malik, 2020). Thus, the world has to depend greatly on a few selected crops like corn, wheat, and paddy which meet 50% of the calorie demand globally (Pirzadah & Malik, 2020). Major cereals lack substantial amounts of micronutrients and

phytonutrients raising concern over hidden hunger arising from micronutrient deficiency among the 2 billion population globally(Bekkering & Tian, 2019). The agriculture sector is the backbone of the nation for providing crops. The selective utilization of few crops has kept global food security at risk (Pirzadah & Malik, 2020). The agricultural sector is already facing many challenges to ensure adequate food supply.

Various under-utilized neglected plants like Buckwheat, have been identified by the Food and Agricultural Organization that can contribute to food security, improving nutrition and health, increasing livelihoods, and sustainable development (Pirzadah & Malik, 2020).

With the newly emerged novel Coronavirus pandemic, there is an increased loss of employment leading to an increase in the risk of a hunger crisis in the world. The role of Buckwheat in the food and agriculture sector is its ability to tackle the hunger crisis globally and generate income (Pirzadah & Malik, 2020).

Globalization and industrialization of agriculture have many adverse effects across the globe that have diminished the genetic diversity in the agricultural sector. Technological interventions use only specific plant species that are in demand for energy utilization and hence lead to selective industrial practices (Pirzadah & Malik, 2020). Buckwheat, a high-demand crop in India, is under-utilized due to widespread ignorance among the population. Technological interventions and awareness campaigns are needed to increase the cultivation and consumption of this crop, as many segments are unaware of its potential.

The existing agricultural pattern gives rise to questions regarding the utilization of only a few that contribute to good nutrition, alleviate poverty, and assure food security. Thus, there is a need to study the various properties of Buckwheat and develop products in order to improve its utilization.

2. REVIEW OF LITERATURE

2.1 Buckwheat

Buckwheat is an ancient crop that is originated in Asia and later introduced into other countries. Despite being underutilized, it plays a crucial role in food security (Babu et al., 2018). It is a minor crop grown in the hills annually in India. It is not a true cereal. It belongs to dicotyledons and

cereals belong to monocotyledons. They have a similar nutrient composition as cereals. Polygonaceae is the family and its genus is *Fagopyrum* spp(Rosentrater & Evers, 2018). In India, of twenty species nine have good nutrient content and two are grown commonly. Common Buckwheat and Tartary Buckwheat are the most commonly grown (Babu et al., 2018; Chen et al., 2018).

2.2 Growth Conditions

Buckwheat grows for a short duration of 3-4 months in regions of higher altitudes (Babu et al., 2018). It is adaptable to varying temperatures, deficient water conditions, lack of nutrient-rich soil, and varying climatic conditions(Luitel et al., 2017). It matures very early and can grow in infertile lands. It supports the livelihood of many individuals residing in hill regions by increasing production due to improved yield in a short period (Babu et al., 2018; Rana et al., 2012).

2.3 Cultivation of Buckwheat

It is an ancient crop cultivated in Asia, India, Canada, Nepal, eastern Russia, Nepal, China, Japan, Mongolia, North Korea and Bhutan. However, its production has declined since the 20th Century(Farooq et al., 2016).

2.4 Nutritional value

Buckwheat, a cereal rich in protein (13.57%), crude fiber (7%), crude fat (3%), amylose (18%), and starch (59-69%), is a nutritional powerhouse with a balanced distribution of amino acids. It contains a good quantity of magnesium, selenium, manganese, potassium, zinc, iron, copper, and phosphorus. Buckwheat's unique composition, rich in lysine, makes it a unique cereal among others (Rauf et al., 2020).

2.5 Flavonoids

Buckwheat is rich in flavonoids, including Vitamin P, an abundant flavonoid (Babu et al., 2018). Its content depends on seed growth factors, flower color, sowing time, soil location, and environmental fluctuations (Babu et al., 2018). It also contains tannins that affect nutrient absorption, astringency, and color. Fagopyrin, a flavonoid found in the fresh green parts of Buckwheat, is recommended to be limited to 40g/day due to hypericin toxicity(Kreft et al., 2013).

2.6 Health benefits

Studies show that slow-digesting carbohydrates improve glycemic profile, making buckwheat a good diabetic food. Buckwheat's nutrient composition includes high-quality protein, fiber, vitamins, minerals, bioactive compounds, and trace elements. Rutin has anti-oxidant and inflammation-reducing properties. It is used in industries like pharmaceuticals and cosmetics, lowering cardiovascular disease risk (Babu et al., 2018; Rana et al., 2012).

Studies indicate that carbohydrates with slow digesting ability help in managing hyperglycemia. It enhances insulin release and lowers its resistance (Vinoy et al., 2016). Buckwheat is rich in complex carbohydrates beneficial for people with Diabetes due to its slow digestion and release capability, making it an effective sugar control agent(Babu et al., 2018)/ Gluten in foods can worsen the condition of tropical sprue in predisposed individuals by triggering the immune system's response (Tye-Din et al., 2018). It does not contain gluten and is beneficial for these individuals (Rauf et al., 2020).

2.7 Culinary uses

Buckwheat is a versatile crop in India, used in various culinary dishes such as leafy chutneys and vegetable curry, nectar-producing honey, and popping seeds. Its flour, known as Kuttu ka atta, is used during fasting, festivals, and devotional purposes. It is also used in baking technology such as breads, and pancakes. Tartary buckwheat is used in the processing of alcoholic beverages (Babu et al., 2018).

3. RESEARCH GAPS

Buckwheat grown in many parts of India, but limited studies are available on detailed nutritional analysis. The utilization of Buckwheat in food industries is limited and hence physico-chemical analysis of Buckwheat would be a resourceful base for technological interventions. The current study is proposed to focus on various food products that can be made from Buckwheat and utilized at a household level and industrial level.

In history, Buckwheat was the staple food among various cultures, and has become underutilized over time and is currently being utilized by small niches globally(Bekkering & Tian, 2019). The crucial sector in the nation is the agricultural sector. Utilizing only a few food grains

will lead to selective cropping that might lead to the risk of global food security to feed the 7 billion individuals of the World predicted to reach 10.9 billion by 2050 and may cause a food crisis(Bekkering & Tian, 2019; Pirzadah & Malik, 2020). There is a need to explore these neglected or under-utilized pseudocereals that need direction and focus in research and development. A multidisciplinary approach is required to review and increase its cultivation and utilization (Pirzadah & Malik, 2020).

Due to the serious consequences of selective crop utilization such as food security, loss of genetic diversity, and hidden hunger, there is a need to undertake research studies. Research studies on physicochemical properties that contribute ideas for technological food product interventions to increase the use of Buckwheat.

4. PROBLEM STATEMENT

Buckwheat, a valuable crop in human nutrition, has been underutilized due to neglect and under-utilization in the food industry, particularly in India. This study aims to explore various food products made from Buckwheat at household and industrial levels, focusing on physicochemical properties and acceptability. The findings could contribute to technological food product interventions, addressing issues such as food security, genetic diversity loss, and hidden hunger. A multidisciplinary approach is needed to improve buckwheat cultivation and utilization.

5. OBJECTIVES OF RESEARCH

- To determine the physicochemical and functional properties of Buckwheat
- To estimate the fatty acids present in Buckwheat
- To estimate the amino acids present in Buckwheat
- To develop extruded products from Buckwheat
- To develop various food products from Buckwheat
- To study the acceptability of developed food products

HYPOTHESIS

H_1: There is a difference between the products made from Buckwheat and Wheat.

6. METHODOLOGY

The research design is an experimental study.

MATERIALS AND METHODS

Test Material: Common Buckwheat (*Fagopyrum Esculentum* Moench*)* will be collected from the local market of Haryana and is identified by the National Bureau of Plant Genetic Resources (NBPGR) Shimla, India)

Physical properties

The physical properties such as 1000 kernel weight, volume, and density are studied. One thousand kernels are manually counted, for which the weight is observed using a digital weight machine and volume will be measured using a measuring cylinder. The weight and volume of the thousand kernels are used to calculate density. The True density is calculated by the water displacement method. The Preweighed thousand grains will be transferred to a measuring cylinder filled with water up to a fixed mark. The volume increased due to water displacement is observed to calculate the true density as g/ml. After soaking in water for 24 hours, the weight and volume of the soaked thousand seeds are recorded.

Functional properties

Functional properties include Hydration capacity, Hydration Index, Swelling capacity, and Swelling Index.

Hydration capacity (g/ 1000 kernels) and Hydration index

Hydration capacity is calculated as per the standard method (Williams et al., 1983). The hydration index is calculated by using the following formula.

$$\text{Hydration capacity}(\%) = \frac{1000 \text{ kernel wt. (after soaking)} - 1000 \text{ kernel wt. (dry)} \times 100}{\text{Wt. of 1000 kernel grains}}$$

$$\text{Hydration capacity/seed} = \frac{1000 \text{ kernal wt. (after soaking)} - 1000 \text{ kernal wt. (dry)}}{1000 \text{ (no. of seeds)}}$$

$$\text{Hydration index} = \frac{\text{Hydration capacity/seed}}{\text{Wt. of one seed}}$$

Swelling Capacity and Swelling Index

The soaked kernels are dried using blotting paper to remove superfluous moisture and poured into a known volume of water in a measuring cylinder to observe the change in volume. The following formula is used to calculate the Swelling index.

$$\text{Swelling capacity}(\%) = \frac{1000 \text{ kernal vol. (after soaking)} - 1000 \text{ kernal vol. (initial)} \times 100}{\text{Wt of 1000 kernal grains}}$$

$$\text{Swelling capacity/seed} = \frac{1000 \text{ kernal vol. (after soaking)} - 1000 \text{ kernal vol. (initial)}}{1000 \text{ (no. of seeds)}}$$

$$\text{Swelling index} = \frac{\text{Swelling capacity/seed}}{\text{vol. of one seed}}$$

Germination

Thousand kernels will be randomly selected and soaked in 300ml distilled water for 24 hours. The soaked grains are drained and all the excess water is removed using a perforated strainer. These grains will be tied tightly in a muslin cloth and allowed for germination for 36 hours by placing them in a dark place. After the sprouting process, these sprouts are classified as completely, partially, or not germinated and counted to know the germination capacity. The values are expressed in percentages.

Chemical properties

Grains are subjected to a laboratory model flour mill. A sample of the whole flour is analyzed by standard procedures for crude protein, moisture, total ash, and total fat, crude fiber.

Moisture

Moisture will be measured using a moisture meter in which a sample of known weight will be placed in a dry moisture plate and dried in an oven at 105°C. Moisture content is calculated by the formula given by the Association of Official Agricultural Chemists (AOAC)(Horwitz, 2005)

Crude Protein and Amino Acid profile

Total nitrogen will be determined using the micro-Kjeldahl procedure(Horwitz, 2005)

Ash:

Ash is determined by the combustion method (Horwitz, 2005)

Total Fat and Fatty acid profile

The crude fat from the flour sample will be extracted using petroleum ether in a Soxhlet apparatus.

Crude fat will be analyzed and Fatty acid analysis will be done by Gas Liquid Chromatography (Horwitz, 2005).

Crude Fibre

It will be analyzed using the acid-alkali digestion procedure (Horwitz, 2005).

Total Carbohydrate:

The total Carbohydrate is calculated by the formula (Horwitz, 2005).

Protein and starch digestibility – *in vitro*

In vitro, protein digestibility is measured using the pepsin pancreatin method (Shastry & John, 1991). *In vitro*, starch digestibility is determined by standard procedure (Proll, 1982).

Protein Digestibility- *In vitro*(Shastry & John, 1991)

A sample of a known weight containing 16mg of Nitrogen is taken in triplicate and allowed for digestion by adding 1mg pepsin in 15 ml of 0.1M Hydrochloric acid at room temperature for 2 hours. 15 ml of 10% trichloroacetic acid (TCA) will be added. This mixture is centrifugated for 5 minutes at the rate of 6300×g. Through a filter paper, this mixture will filtered quantitatively. The digestible protein will be analyzed for nitrogen using the micro-Kjedahl method and expressed as a percent of total Nitrogen (Horwitz, 2005).

Starch Digestibility *In vitro*

In a test tube, 50 mg of the sample is taken, and 1 ml of 0.2 mol phosphate buffer of pH 6.9 is mixed. In a separate cylinder, 20mg of alpha-amylase is dissolved in 50 ml of phosphate buffer. 0.5 ml of the buffer is added and kept at 37°C for 2 hours. Immediately after 2 hours to the sample, a quantity of 2 ml of reagent is added and subjected to heat for 10-15 minutes. After 15 minutes of heating the mixture, 1 ml of 40% Tartarate solution is added. It is cooled at room temperature. This solution is made up to 25 ml by adding distilled water, and the absorbance at 550 nm is taken. A standard curve is drafted using maltose. Values will be observed as mg maltose released per 100mg of sample(SINGH et al., 1982).

Cooking quality

Cooking Time

A sample of known weight will be soaked for 30 minutes and will be boiled. This sample is cooked till the desired consistency of cooked grain is obtained. The time required for complete gelatinization will be noted down. The completion of the Gelatinization process will be noted. Cooked weight (g) and volume (ml) will noted.

Popping

1000 grains will be popped by the dry heat application in a thick bottom pan by using 2.5ml cooking oil. The popped grains will be separated and counted to classify them as completely popped, partially popped, and unpopped, and the values are expressed in percentage.

Product development

Buckwheat flakes are produced by roller-flaking machines. Vermicelli, noodles are produced by the Extrusion method.

Products such as Buckwheat Muesli, Idli, Dosa, Chocos, Vermicelli kheer, Noodles, Muesli, Plain Flakes and malted complementary mix will be developed and subjected to sensory evaluation by semi-trained panelists.

Sensory Evaluation of Developed Products:

Sensory Evaluation of developed products along with control (Wheat) will be carried out by 15 semi-trained panelists from the field of food and nutrition.

The samples will be coded with an Alphabet letter. Two sample will be given at a time. The evaluation of samples will be done in Separate ventilated cabins at room temperature. Panelists will be given drinking water to rinse the mouth before tasting each sample.

Subjective evaluation will be done using a 9-a-point hedonic scale.

Statistical Analysis

The difference in sensory evaluation of products will be done using the Mann-Whitney U test using SPSS 20.0 software at a 5% level of significance. The relationship between grain characteristics will be determined by Correlation.

7. EXPECTED OUTCOME OF RESEARCH

- This study focuses on the various physicochemical, functional properties of Buckwheat that could meet the requirements of product specific applications in food industry and other non food industries.
- Buckwheat has a very strong ability to gain importance in the food industrial sectors as well as to tackle the global hunger crisis and become a source of income generation.
- Buckwheat's nutritional profile will enable it to emerge as a superfood.
- Extruded products can give new product ideas to various food technologists.
- Acceptability of processed food products made from it would increase the utilization of the daily diet.

REFERENCES

Babu, S., Yadav, G. S., Singh, R., Avasthe, R. K., Das, A., Mohapatra, K. P., Tahashildar, M., Kumar, K., Prabha, M., Thoithoi Devi, M., Rana, D. S., Pande, P., & Prakash, N. (2018). Production technology and multifarious uses of buckwheat (Fagopyrum spp.): A review. *Indian Journal of Agronomy*, *63*(4), 415–427.

Bazile, D., Jacobsen, S.-E., & Verniau, A. (2016). The Global Expansion of Quinoa: Trends and Limits. *Frontiers in Plant Science*, *7*, 622. https://doi.org/10.3389/fpls.2016.00622

Bekkering, C. S., & Tian, L. (2019). Thinking Outside of the Cereal Box: Breeding Underutilized (Pseudo)Cereals for Improved Human Nutrition. *Frontiers in Genetics*, *10*, 1289. https://doi.org/10.3389/fgene.2019.01289

Chen, Q. F., Huang, X. Y., Li, H. Y., Yang, L. J., & Cui, Y. S. (2018). Recent progress in perennial buckwheat development. *Sustainability (Switzerland)*, *10*(2), 5–7. https://doi.org/10.3390/su10020536

Das, S., & Das, S. (2016). Pseudocereals: An Efficient Food Supplement. In *Amaranthus: A Promising Crop of Future* (pp. 5–11). Springer Singapore. https://doi.org/10.1007/978-981-10-1469-7_2

Farooq, S., Rehman, R. U., Pirzadah, T. B., Malik, B., Dar, F. A., & Tahir, I. (2016). Cultivation, Agronomic Practices, and Growth Performance of Buckwheat. In *Molecular Breeding and Nutritional Aspects of Buckwheat* (pp. 299–313). Elsevier Inc. https://doi.org/10.1016/B978-0-12-803692-1.00023-7

Horwitz, W. (2005). *Official methods of analysis of AOAC International* (18th ed.). AOAC International.

Kreft, S., Janeš, D., & Kreft, I. (2013). The content of fagopyrin and polyphenols in common and tartary buckwheat sprouts. *Acta Pharmaceutica*, *63*(4), 553–560. https://doi.org/10.2478/acph-2013-0031

Luitel, D. R., Siwakoti, M., Jha, P. K., Jha, A. K., & Krakauer, N. (2017). An Overview: Distribution, Production, and Diversity of Local Landraces of Buckwheat in Nepal. *Advances in Agriculture*, *2017*, 1–6. https://doi.org/10.1155/2017/2738045

Pirzadah, T. B., & Malik, B. (2020). Pseudocereals as superfoods of 21st century: Recent technological interventions. *Journal of Agriculture and Food Research*, *2*, 100052. https://doi.org/10.1016/j.jafr.2020.100052

Proll, J. (1982). Nutritional Evaluation of Protein Foods. Herausgegeben von P. L. PELLET and V. R. YOUNG. 154 Seiten, 6 Abb., 18 Tab. The United Nations University Japan 1980. *Food / Nahrung*, *26*(3), 323–323. https://doi.org/10.1002/food.19820260315

Rana, J., Chauhan, R., Sharma, T., & Gupta, N. (2012). Analyzing Problems and Prospects of Buckwheat Cultivation in India. *Eur. J. Plant Sci. Biotechnol*, *6*(2), 50–56.

Rauf, M., Yoon, H., Lee, S., Hyun, D. Y., Lee, M. C., Oh, S., & Choi, Y. M. (2020). Evaluation of Fagopyrum esculentum Moench germplasm based on agro-morphological traits and the rutin and quercetin content of seeds under spring cultivation. *Genetic Resources and Crop Evolution*, *3*. https://doi.org/10.1007/s10722-020-00899-3

Rosentrater, K. A., & Evers, A. D. (2018). Introduction to cereals and pseudocereals and their production. In *Kent's Technology of Cereals* (pp. 1–76). Elsevier. https://doi.org/10.1016/b978-0-08-100529-3.00001-3

Shastry, M., & John, E. (1991). Biochemical changes and in-vitro protein digestibility of the endosperm of germinating dolichos lablab. *Journal of the Science of Food and Agriculture*, *55*(4), 529–538. https://doi.org/10.1002/jsfa.2740550405

SINGH, U., KHERDEKAR, M. S., & JAMBUNATHAN, R. (1982). Studies on Desi and Kabuli Chickpea (Cicer arietinum L.) Cultivars. The Levels of Amylase Inhibitors, Levels of Oligosaccharides, and In Vitro Starch Digestibility. *Journal of Food Science*, *47*(2), 510–512. https://doi.org/10.1111/j.1365-2621.1982.tb10113.x

Tye-Din, J. A., Galipeau, H. J., & Agardh, D. (2018). Celiac disease: A review of current concepts in pathogenesis, prevention, and novel therapies. *Frontiers in Pediatrics*, *6*. https://doi.org/10.3389/fped.2018.00350

Vinoy, S., Laville, M., & Feskens, E. J. M. (2016). Slow-release carbohydrates: Growing evidence on metabolic responses and public health interest. Summary of the symposium held at the 12th European Nutrition Conference (FENS 2015). *Food and Nutrition Research*, *60*. https://doi.org/10.3402/fnr.v60.31662

Williams, P. C., Nakoul, H., & Singh, K. B. (1983). Relationship between cooking time and some physical characteristics in chickpeas (Cicer arietinum L.). *Journal of the Science of Food and Agriculture*, *34*(5), 492–496. https://doi.org/10.1002/jsfa.2740340510

MANAV RACHNA
vidyanatariksha

Dr. O.P. Bhalla Central Library
Manav Rachna International Institute of Research and Studies
(A deemed-to-be-university under section 3 of UGC Act 1956)

SIMILARITY VERIFICATION CERTIFICATE

Title: Physico-chemical Characterization of Buckwheat Grain & Optimization and Development of its products

Researcher: Aneesha

Registration Number: 19/PhD/001

Supervisor: Dr. Pratibha Singh

Department: Nutrition and Dietetics

This is to certify that the above mentioned Short Synopsis/Thesis was scanned for similarity index through iThenticate Software on 08/02/2025 with submission ID 3618136934 and the similarity index was found to be 5 %. The complete report running into 15 Pages, 3579 Word count with File Size 269.5 KB/MB is being forwarded to the Research Supervisor/DRC/DRB for review.

Date: 08/02/2025

Rajesh Kumar
Dr. Rajesh Kumar
University Librarian
Dr. O.P. Bhalla Central Library
Manav Rachna International
Institute of Research & Studies
Faridabad

The complete report of the above Short Synopsis/Thesis has been reviewed and the similarity index is below the accepted norms as per the University Grants Commission (Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions) Regulations 2018. The Short Synopsis/Thesis may be considered for further processing

Aneesha
Research Scholar
(Aneesha)

08/02/2025
Research Supervisor
Dr. Pratibha Singh

Submission ID trn:oid:::3618:81369343

Dr. Pratibha Singh
Professor

Aneesha
Research Scholar

Aneesha

PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN OPTIMIZATION AND DEVELOPMENT OF ITS PRODUC...

Manav Rachna International Institute of Research and Studies

Document Details

Submission ID
trn:oid:::3618:81369343

Submission Date
Feb 7, 2025, 3:49 PM GMT+5:30

Download Date
Feb 8, 2025, 10:59 AM GMT+5:30

File Name
PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN OPTIMIZATION AND DEVELOP....docx

File Size
269.5 KB

15 Pages

3,579 Words

20,243 Characters

Dr. Rajesh Kumar
University Librarian
Dr. O.P. Bhalla Central Library
Manav Rachna International
Institute of Research & Studies
Faridabad

Excluding matches
less than 14 words

Submission ID trn:oid:::3618:81369343

Dr. Pratibha Singh
Professor

Aneesha
Research Scholar

Aneesha

PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN OPTIMIZATION AND DEVELOPMENT OF ITS PRODUC...

Manav Rachna International Institute of Research and Studies

Document Details

Submission ID
trn:oid:::3618:81369343

Submission Date
Feb 7, 2025, 3:49 PM GMT+5:30

Download Date
Feb 8, 2025, 10:59 AM GMT+5:30

File Name
PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN OPTIMIZATION AND DEVELOP....docx

File Size
269.5 KB

15 Pages

3,579 Words

20,243 Characters

Dr. Rajesh Kumar
University Librarian
Dr. O.P. Bhalla Central Library
Manav Rachna International
Institute of Research & Studies
Faridabad

Excluding matches
less than 14 words

5% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography
- Small Matches (less than 10 words)

Aneesha
(Research Scholar)

Dr. Pratibha Singh
(Professor)

Match Groups

- 8 Not Cited or Quoted 4%
  Matches with neither in-text citation nor quotation marks
- 2 Missing Quotations 1%
  Matches that are still very similar to source material
- 0 Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

5% Internet sources
2% Publications
0% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Dr. Rajesh Kumar
University Librarian
Dr. O.P. Bhalla Central Library
Manav Rachna International
Institute of Research & Studies
Faridabad

Excluding matches
less than 14 words

Match Groups

- 8 Not Cited or Quoted 4%
  Matches with neither in-text citation nor quotation marks
- 2 Missing Quotations 1%
  Matches that are still very similar to source material
- 0 Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

5% Internet sources
2% Publications
0% Submitted works (Student Papers)

Aneesha
Aneesha
(Research Scholar)

Dr-Pratibha Singh
Professor

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Internet	
shodhgangotri.inflibnet.ac.in		1%
2	Internet	
www.ijcmas.com		<1%
3	Internet	
www.vup.sk		<1%
4	Internet	
www.ijmrhs.com		<1%
5	Internet	
www.scielo.br		<1%
6	Publication	
"Agricultural Biotechnology: Latest Research and Trends", Springer Science and B...		<1%
7	Publication	
Margaret O. Edet, Florence A. Bello, Babatunde S. Oladeji. "Development and eval...		<1%
8	Publication	
Rajkumari Jashmi Devi, Nikhil K. Chrungoo. "Evolutionary divergence in Chenopo...		<1%
9	Internet	
krishikosh.egranth.ac.in		<1%

Excluding matches
less than 14 words

Dr. Rajesh Kumar
University Librarian
Dr. O.P. Bhalla Central Library
Manav Rachna International
Institute of Research & Studies
Faridabad

PHYSICO-CHEMICAL CHARACTERIZATION OF BUCKWHEAT GRAIN: OPTIMIZATION AND DEVELOPMENT OF ITS PRODUCTS

SHORT SYNOPSIS

Submitted in partial fulfillment of the requirement of the degree of

DOCTOR OF PHILOSOPHY

to

Manav Rachna International Institute of Research and Studies

(Deemed to be University)

Aneesha

Registration Number: 19/PhD/001

Under the supervision of

Supervisor

Dr. Pratibha Singh
Professor
Department of Nutrition and Dietetics

Department of Nutrition and Dietetics
School of Allied Health Sciences
Manav Rachna International Institute of Research & Studies
Sector-43, Surajkund–Delhi Road, Faridabad– 121004

ABSTRACT

Buckwheat is an ancient crop grown in hilly regions around the world. It is a highly sustainable crop due to its adaptability to various climatic conditions. It has grown for many years, but its production and importance have declined due to neglect and under-utilization in the world and India. This has shortened the supply chain while increasing the consumption limits. The present study aims to study the physicochemical properties of Buckwheat and the acceptability of its